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ABSTRACT

Written for beginners, this user's manual explains how to do microcomputer (MC) painting with the Microcomputer System for Educational Applications (MSEA) of the University of Illinois' Department of Secondary Education. It requires no knowledge of computers, and a step-by-step approach to the use of the many different tools used in this medium is provided. Instructions are given for starting the microcomputer and the microcomputer painting systems; equipment and the MC painting tools are described; and the user is told how to: paint with the narrow brush, erase, turn the system off, make shuffling transformations, save a painting, display the list of files (paintings or programs), load (recall) a saved painting, make a motif, make a block print, draw lines automatically, choose painting, and make a color-coded INFOTON Display of selected paintings. The three types of pure color mapping in the program are also explained. A table of the colors and their codes are appended. (JD)

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The Illinois Series

on

Educational Applications of Computers

INSTRUCTIONS FOR MICROCOMPUTER PAINTING

Carmen Kosan and Bruce Hicks

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March 1979

Department of Secondary Education
College of Education
University of Illinois
Urbana, Illinois

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Preface

Two earlier ISEAC reports, Nos. 16 and 25, have described microcomputer (MC) painting and its applications. The present report is a User's Manual for microcomputer painting with the Department's computer system MSEA.† We are indebted to many students for their help in improving the Manual.

Microcomputer painting is easy to do and requires no knowledge of computers. There are, however, many different tools in this new medium. This User's Manual is written for beginners and therefore gives details of their use of each of these tools, step by step. They can start to do MC painting after studying just the first five sections. More advanced users will find that Section III is a convenient summary of the different tools.

Later reports (Nos. 31 and 32) will document the computer programs for MC painting and describe a computer-based file that provides an easy way to index and categorize the many MC paintings that can be made and are worth preserving for further study and enjoyment.

† See ESEAC Nos. 20 and 29. The parts of MSEA used in the MC painting are the MMSAI 8080 microcomputer (with Cronemco Dazzler interspace), iCOM Dual Floppy Disk Drives, INFOTON terminal, modulator and a commercial color T.V. We have also implemented MC painting on the APPLE II microcomputer, and it can be implemented on any microcomputer with color graphics and joystick or paddles.

ISEAC Number 30

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Instructions for Microcomputer Painting

Carmen Kosan and Bruce Hicks

1. STARTING THE MICROCOMPUTER SYSTEM

   a) Connect the Infoton terminal and color TV to the microcomputer if they are not already connected. (Consult "Microcomputer System for Educational Applications-User Guide to System Operations"† on how to proceed).

   b) Turn on the power of the IMSAI 8080, iCOM Dual Floppy Disk System, Infoton terminal, and color TV. Be sure the terminal is set to "line".

   c) In the left part of the IMSAI 8080 panel (called "Address-Programmed Input") there are four blue switches. They are numbered 4,5,6 and 7 from the right to the left. Flip up switches 6 and 7. All the other switches should be down.

   d) Place user disk "Infoton Boot-up; Provisions for Running *RI and *PO" on Drive 0. The "up" side of the disk is the side with a paper label on it. The label should be at the front of the Floppy Disk System. Note: do not try to "catch" the door as you open it, simply let the door fall open. Be sure to close the door on disk Drive 0.

   e) Wait for the red READY light of the Floppy Disk System to go on.

   f) Flip the red STOP switch down on the IMSAI 8080.

   g) Flip the blue EXAMINE switch up on the IMSAI 8080.

† Unpublished document in the Department of Secondary Education.

h) Flip the red RUN switch up on the IMSAI 8080.

i) You will hear a "click" as the disk begins to work, and after a few seconds the following message should appear on the Infoton terminal: "ICOM FDOS-III ALTAIR/IMSAI VER. 1.0."

j) A prompt (!) will appear on the terminal indicating that the system is ready for a command.

k) Flip switches #6 and #7 down. (You will use these switches later for other purposes.

II. STARTING THE MICROCOMPUTER PAINTING SYSTEM.

a) Place user disk (#101, for example) on Drive 1 with label "up" and at front. Be sure to close the door on disk Drive 1.

b) Then type:

RUN, *ZH10:1 Note: The keyboard gives upper case letters automatically - no need to use the shift key.

c) Press -RETURN- key.

d) You will hear a "click" and another prompt (>) will appear on the terminal.

e) Then type:

G8000

f) Press -RETURN- key.

g) The color TV is on and ready. You will see on the TV screen many colored squares.

h) You are now ready to begin using the MC† Painting System.

† MC stands for microcomputer.

III. DESCRIPTION OF THE EQUIPMENT AND MC PAINTING TOOLS.

In Figure 1 you will see one of the two joystick boxes each with four buttons and one joystick. The joystick controls the position of the cursor†. The two sliders on each box set the "zero" position of the joystick, that is, the position it takes when it has not been moved to some other position by the user.

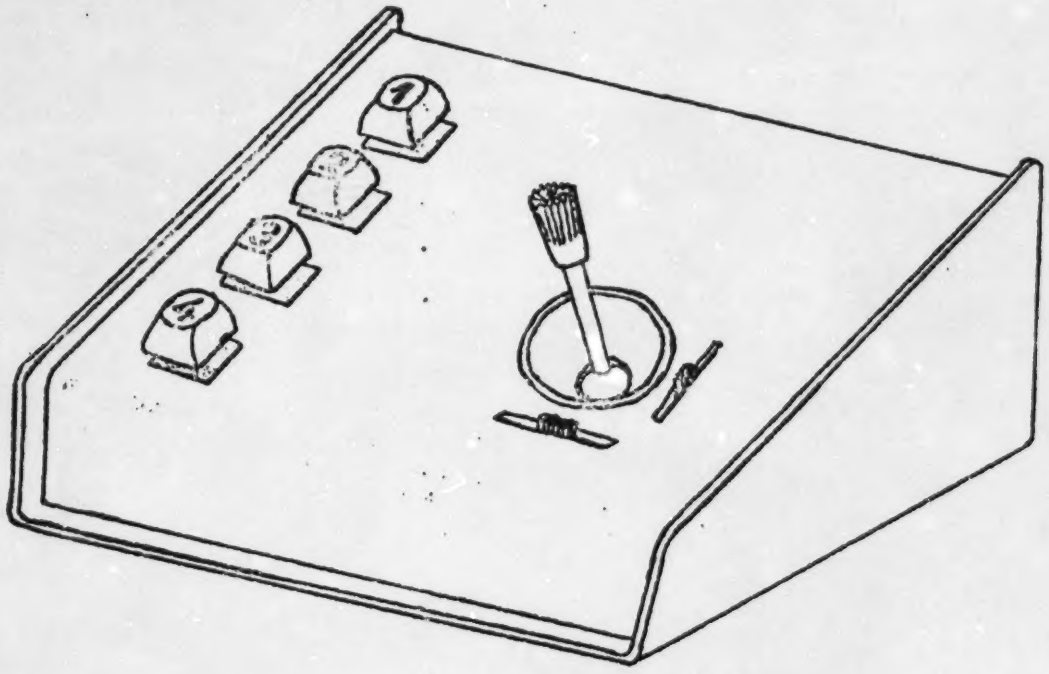

FIGURE 1. A Joystick and its Buttons - Box A

† Cursor: a small blinking spot on the TV screen which shows where the MC paint brush can paint or pick up a color on the TV screen.

The eight buttons, the joystick and eight switches on the IMSAI 8080 panel control all the functions or tools of the MC painting. It is useful to summarize here all of the functions of the buttons and switches. The details of operations are given in later sections.

1) Buttons used in the painting mode.

BOX A

Buttons	Function
#1	for getting color from the palette† or anywhere on the TV screen
#2	for painting
#3	for erasing the palette
#4	for putting the palette on the TV screen

BOX B

Buttons	Function
#5	for getting ground color
#6 (and #1-#4)	for block printing (see Sections XII and XIII.)
#7 (and #1,#3,#4)	for pure color mapping†† (see Section XIX.)
#3	goes to shuffling mode††

NOTE: the buttons of this box B are named 5, 6, 7 and 8 instead of 1, 2, 3 and 4.

† Palette: 15 colors (two intensities of each of seven colors plus two blacks). See the Appendix.

†† Mapping or transformation is the action of the computer in changing one spot of color to another one or changing the shape of parts of the painting. The shuffling transformation creates a "shuffling" effect. (See Section VII.)

2) Buttons used in the shuffling mode.

BOX A

Buttons	Functions
#1	for the "shuffling" transformation
#2	for reverse shuffling transformation
#3	for color plus shuffling transformation
#4	none

BOX B

Buttons	Functions
#5	none
#6	goes to painting mode
#7	goes out for a new system command (see section Ij)
#8	none

NOTE: the buttons of this Box B are named 5,6,7 and 8 instead of 1, 2, 3 and 4.

NOTE*: If you are in the painting mode, you can go the shuffling mode by tapping button #8. If you are in the transformation mode, you can go to the painting mode by tapping button #6. If you can see the cursor you are in the painting mode; if not, you are in the shuffling mode.

3) INSAI Panel Switches used. (See Sections XIII, XIV, XV, XVI, and XIX.)

	Functions			
Switches	Block Printing	Lines	Four Brushes	Pure Color Mapping
#0		X		X
#1		X		X
#2		X		X
#3		X		X
#4			X	X
#5			X	X
#6†	X	X		X
#7†	X			X

IV. HOW TO PAINT WITH THE NARROW BRUSH

a) When the color TV is on and ready, tap button #5 and the screen of the TV will change to some solid color (that is, to the "ground" color). In the middle of it you will see the blinking cursor. Move the joystick and you will see the cursor move.

b) Tap button #4 and the palette†† will appear at the top of the TV screen.

c) Use the joystick to move the cursor to some part of the palette and hold it there.

NOTE: button #4 also restores the brush color indicator (see step d) and the color mapping indicators (see Section XIX, part 2).

† Switches #6 and #7 are also used for bringing in the FDOS (as in step i), Section I.

†† The colors in the palette are described in the Appendix.

d) Tap button #1. You will see a little rectangle at the left of the palette (the "brush color indicator"). That means, that the brush now has the color of the square where the cursor is. Now you can move the cusor to where you want to paint.

e) Press and hold down button #2 to paint. You have the choice of making a continuous brush stroke (while you hold down the button) or a dab - an isolated square of color (when you tap the button instead of holding it down). Use your imagination!

f) To change the color in the brush, move the cursor to the palette (or any part of the screen) and pick a different color. Tap button #1 and you will see again the little rectangle to the left of the palette with the new color. Tap or press and hold down button #2 and you can continue painting.

V. HOW TO ERASE.

a) To erase only one spot of your painting, put on the brush the color of the background† by moving the cursor to a spot in the background and tapping button #1. Now move the cursor to the spot to be erased and tap button #2 once.

b) To erase the palette (by changing the top line to black), tap button #3. If you later tap button #4 you will display both the palette and the current brush colors and mapping indicators on the top line.

c) To erase the painting totally, tap button #5.†† You will notice that the new color of the TV screen depends on the position of the cursor.

† The background is initially black but can be changed to any other color by step c) or by application of the steps in part 2 or 2' of Section XIX.

†† When you tap button #5 you lose the painting that was on the screen, but you do not affect the painting stored on the disks (see Section VIII).

For example, if the cursor is on a pink spot, and you tap button #5, then the TV screen will become pink.

VI. HOW TO TURN THE SYSTEM OFF.

a) Flip the red STOP switch down on the IMSAI 8080.

b) Open the doors on Drive 0 and Drive 1.† Take the two disks out, put them in their envelopes and file them.

c) Turn off the power of the IMSAI 8080, iCOM Dual Floppy Disk System, Infoton terminal, and the color TV set.

VII. HOW TO MAKE SHUFFLING TRANSFORMATIONS.

a) Make a painting or load one from the disk. (See Section X.)

b) Get in the shuffling mode. (See NOTE* in Section III, p. 5.)

c) Tap button #1 and you will see a (shuffling††) transformation of your painting. Each tap transforms the painting again. You can see five different transformations. The sixth time you will see the original painting.

d) If you want to change colors in the painting during the process of shuffling, press and hold down button #3 and tap button #1.

† Always let each door fall freely when you open it.

†† See further discussion of this transformation in Section 3 of ISEAC No. 25. (A Multi-Purpose Educational Medium - MC Painting, Zibit and Hicks, October 1973.) You can think of the 64 rows of squares on the TV screen as being colored edges of two decks of cards, placed side by side, each deck containing 64 cards. You are looking at these colored edges of the cards. When you tap button #1, the two decks are perfectly shuffled once - hence the name "shuffling" transformation. You can demonstrate this shuffling by making a MC painting in which the left side is all of one color and the right side is all of another color. Then when you tap button #1 in the shuffling mode you will see the shuffling take place.

e) If you want to reverse the shuffling transformation (that is, to "deshuffle") hold down button #2 and tap button #1.

f) If you want to reverse the color and shuffling transformations hold down buttons #2 and #3 and tap button #1.

VIII. HOW TO SAVE A PAINTING.†

a) When the painting you want to save is on the TV screen, then go to the shuffling mode. (See NOTE* in Section III, p. 5.) Tap button #1 once to make one shuffling transformation of your painting.††

b) Tap button #7 and you will get out of the program, that is, the screen of the TV will become black and you will hear a "click". After a few seconds you will see on the Infoton terminal a prompt (!). This indicates that the computer is ready for a command. NOTE: you have to give a name to your painting (no more than 5 letters). Suppose the painting is to be called "JANE*".

c) Then type:

MTDK', JANE*: 1†††

d) Press -RETURN- key. You will see the following message: READ, WRITE, FDOS or MONITOR

e) Then type:

W

f) You will see on the Infoton terminal:

MANUAL or AUTO

† Using a similar method you can save a "motif" (made as in Section XII) and load it again for block printing (see Sections X and XIII).

†† The shuffling is necessary in order that the computer will print a color-coded picture that looks like the MC painting on the TV screen.

††† The "1" indicates that you will save the painting on the disk on Drive 1. The "*" indicates that the painting has been shuffled once on the TV screen.

g) Then type:

A

h) You will see:

BYTES PER RECORD

i) So type:

32 and press -RETURN- key.

j) You will see:

ENTER LO MEMORY ADDR

k) Type:

A000H and press -RETURN- key.

l) You will see:

ENTER HIGH MEMORY ADDR

m) Then type:

A7FFH and press -RETURN- key and you will hear a "click". After a few seconds your painting has been saved on the disk and the prompt (!) reappears. If you want to be sure that your picture has been saved follow instructions in section IX.

IX. HOW TO SEE THE LIST OF FILES (PAINTINGS OR PROGRAMS).

In order to see what paintings or programs are on the disk on Drive 1 type:

List,1 and Press -RETUR- key. You should see "JANE*" at the end of the list on the Infoton terminal if this was the painting (or other file) stored most recently on the disk.

X. HOW TO LOAD (RECALL) A SAVED PAINTING.

a) Get in the transformation mode. (See NOTE* in Section III, p. 5.)

b) Tap button #7 and you will get out of the program. You will hear a "click" and you will see on the Infoton terminal the following message:

ICOM FDOS-III ALTAIR/IMSAI VER. 1.0 and the prompt (!).

c) If JANE* is the painting you want to see, then type:

JANE*:1† and press -RETURN- key. You will hear a "click and after a few seconds another prompt (>) will appear. The painting JANE* has now been loaded (recalled) from the disk.

d) Then type:

G3000 and press -RETURN- key. You will see "JANE*" on the TV screen.

e) Tap button #8 and then hold button #2 while you tap button #1 (to "deshuffle" the painting). You will n w see the HC painting "JANE*" on the screen in its original deshuffled form.

XI. HOW TO DELETE A SAVED PAINTING.

a) Get in the shuffling mode. (See NOTE* in Section III, p. 5.)

b) Tap button #7 and you will get out of the program, that is, the screen of the TV will become black and you will hear a "click". Wait until the prompt (!) appears on the Infoton terminal.

c) Suppose you want to delete the painting "JANE*" that is on the disk on Drive 1, then type:

† The 1 indicates that you will load the painting from the disk on Drive 1.

DELPK: 1, JANE*

d) Press -RETURN- key. You will hear a "click" and on the Infoton terminal will appear:

JANE* DELETED

PACKING DISK

e) The prompt (!) will appear for a new command after the packing is completed.

XII. HOW TO MAKE A MOTIF.

A motif is made by storing the color and relative position of a set of colored squares that are on the screen. The set may contain up to 64 squares and can use any of the 15 colors.

a) First make the set of colored squares by painting (see Section IV, XV and XVI, for example) or choose the squares you want from some painting. Also get a brush color that is different from any color in this set of squares.

b) Put the cursor on one square near this set of squares; hold down button #6 and tap button #4. You will see that one square change to a cross† of the color of the brush. The center square of this cross will be the "marker" square. It is the position of each colored square relative to this "marker" that will be stored as you make the motif.

c) To store the colors and positions of the squares in the set and of the marker itself: put the cursor on one square in the set, hold down button #6 and tap button #1. You have now stored the color and relative position of that square.

† In another version of the motif generation the colored cross at the cursor position is replaced by a single square of a different color.

d) Repeat part "c" for each of the other squares in the set and also for the "marker".† You have now stored the whole motif.

XIII. HOW TO MAKE A BLOCK PRINT

A block print is made by printing (plotting on the screen) one or more copies of a "motif" or pattern of colored squares that has been stored in the computer. Do step b) if you want to use the "test motif" or step b') if you want to use a motif that you have made and stored.

a) To get the ground color, press button #5 with the cursor on the color you chose for the ground.

b) Flip up switch #7, hold down button #6 and tap button #2. The test motif (a set of four colored squares) will appear on the TV screen near the location of the cursor. Use the joystick to move the cursor, and you will see the colored squares making copies of the test motif or going together into four lines (or brush strokes), depending upon the movement of the joystick and whether you tap or hold down button #2 while you hold down button #6. DO NOT flip up switch #7 after making your own motif unless you don't need to save it. Using switch #7 with buttons #6 and #2 replaces any stored motif with the test motif.

b') Prepare your own motif as in Section XII. Hold down button #6 and tap button #2.††(Be sure switch #7 is down.) The motif (the set of little colored squares you have stored) will appear on the screen near the location of the cursor. (The position of the center of the marker in the motif that is plotted coincides with the position of the cursor.)

† You can use the marker as a guide in choosing positions of the motif in making a block print.

†† If you flip up switch #6 before tapping button #2 you will see the cursor run rapidly through the spots in the motif without painting them on the TV screen.

Use the joystick to move the cursor, and you will see the colored squares making copies of the motif or going together into multiple lines (or brush strokes), depending upon the movement of the joystick and whether you tap or hold down button #2 while you hold down button #6.

Hold down button #6 and tap or hold down button #3. The same motif pattern as in step b) or b') is now used to plot individual copies of the motif or multiple lines, but now all in one color, that of the brush.

XIV. HOW TO DRAW LINES AUTOMATICALLY.

In the left part of the IMSAI 8080 panel (called "Address-Programmed Input") there are four red switches. These switches are named 0, 1, 2 and 3 from right to left.

1) How to see the directions of the different lines:

a) Flip up switch #6.

b) Flip up switches #0 and #1, and tap button #2. You will see the cursor running across to the left.

c) Flip up switch #1, tap button #2 and the cursor will run across to the right.

d) Flip up switches #2 and #3, tap button #2 and the cursor will go down.

e) Flip up switch #3, tap button #2 and the cursor will go up.

f) Flip up switches #1 and #3, tap button #2 and the cursor will go the northeast.

g) Flip up switches #0, #1 and #3, tap button #2 and the cursor will go the the northwest.

h) Flip up switches #0, #1, #2 and #3, tap button #2, and the cursor will go to the southwest.

i) Flip up switches #1, #2, and #3, tap button #2 and the cursor will go the southeast.

2) How to paint different lines:

a) Tap button #4 and the palette will appear at the top of the TV screen.

b) Move the cursor to the palette or any part of the screen to pick one color.

c) Tap button #1. You will see a little rectangle (the brush color indicator) at the left of the palette. Move the cursor to the point on the screen where you want the line to start.

d) If you want to paint a single line which goes up, put switch #6 down, and flip up switch #3.

e) Tap button #2 and you will see a line plotted (of the color of your choice) from where the cursor is to the top of the TV screen.

f) If you hold down button #2 and move the joystick, you will paint multiple lines. These lines will be adjacent if you do not move the joystick too fast.

NOTE: Repeat the same operation mentioned above with different switches for the different directions of the lines, as described in part 1.

XV. HOW TO CHOOSE DIFFERENT BRUSHES.

In the left part of the IMSAI 8080 panel (called "Address-Programmed Input") there are four blue switches named 4, 5, 6 and 7. Switch #4 provides

a wide brush, and it is used to paint a "dab" that is three squares wide and one square high. Switch #5 provides one narrow brush, and it is used to paint a "dab" that is one square wide and three squares high. Switches #4 and #5 together provide a wide brush in the shape of a cross.

XVI. HOW TO PAINT WITH DIFFERENT BRUSHES.

a) Tap button #4 and the palette will appear at the top of the TV screen.

b) Move the cursor to the palette or any spot whose color is the one you want.

c) Tap button #1 and a little rectangle (the brush color indicator) will appear at the left of the palette.

d) Flip up blue switch #4 to get the horizontal brush.

e) Tap or hold down button #2 and move the joystick. With this procedure you can paint horizontal rectangles or wide vertical lines and narrow horizontal lines.

f) Flip up switch #5 instead of #4. Repeat the same procedure as in e) and you will now paint vertical rectangles or narrow vertical lines and wide horizontal lines.

g) Flip up switches #4 and #5. You can paint crosses or lines that are wide both horizontally and vertically.

XVII. HOW TO MAKE A COLOR-CODED PRINT OF YOUR PAINTING.†

a) Get in the shuffling mode. (See NOTE* in Section III, p. 5.)

† Color-coded prints can also be made of motifs (and later loaded individually for use in block printing) and of sets of motifs (and later loaded for viewing or copying.)

b) Press button #7. You will see that the TV screen goes black and you will hear a "click". After a few seconds the prompt (!) will appear on the Infoton terminal.

c) Then type:

LIST,1 and press -RETURN- key. You will hear a "click" and the prompt (!) will appear again.

d) Choose one of the paintings listed (say JANE*).

e) Then type:

RUN, *PO and press -RETURN- key. You will hear a "click" and the prompt (>) will appear.

f) Type:

G40 and press -RETURN- key.

g) You will hear a "click" and the following message should appear in the Infoton terminal:

ICOM FDOS - III ALTAIR/IMSAI VER. 1.0 and the prompt (!) will appear again.

h) Turn on the printer by pushing the top two buttons.

i) Then type:

PRINT, JANE*:1 and press -RETURN- key.

j) You will hear a "click", and your painting will be printed by the printer in a few seconds.

This is a "color-coded print", that is, each square of color on the screen is represented in the print by the code for this color. (See the Appendix for the color codes)

An example of a color-coded print is shown in Figure 2. A few lines

have been added to outline some of the "B" spots. (B is the code for red-orange.)

XVIII. HOW TO MAKE A COLOR-CODED INFOTON DISPLAY OF YOUR PAINTING.

Do steps a), b), c), d), and e) the same way as in Section XVII.

† f) You will see the prompt (>), so type:

MFO3D and press -RETURN- key.

You will see on the Infoton: FO3D = F5

g) Type:

C3

You will see: FO3E = DB

h) Now type:

OD

You will see on the Infoton: FO3F = 03

i) Type:

FO

You will see: FO40 = E6

j) Press -RETURN- key. You will see on the Infoton terminal the prompt (>). Type:

G40 and press -RETURN- key.

You will hear a "click" and the following message should appear:

ICOM FDOS-III ALTAIR/IMSAI VER. 1.0 and the prompt (!).

k) Type:

DUMP,JANE*:1 and press -RETURN- key.

† In steps f), g), h), and i) you are changing the program in the memory of the microcomputer so that the output will be to the Infoton terminal rather than to the printer.

1) You will hear a "click", and the color-coded display of your painting will be printed on the Infoton terminal, in the same format and the same color codes used by the printer (see Section XVII and Appendix).

XIX. PURE COLOR MAPPING.

There are three types of pure color mapping in this program:

1) Change every color in a MC painting to a new color. These changes are reversible.
2) Change one color to a second color in a MC painting. This change will not be reversible if the second color was already present in the painting.
3) Interchange two colors in the painting. This change is reversible.

1) How to change every color in a MC painting:

a) Get into the painting mode. (See NOTE* in Section III, p. 5.)

b) Set switches #0, #1, #2, and #3 to the amount by which you want to chang each color in the painting. EXAMPLE: set the four switches to 0001 (that is, switches #3, #2 and #1 down and switch #0 up), indicating that you want to shift each color to the color immediately to the left of it in the palette.†

c) Hold down buttons #7†† and #3†† until the colors start to change.

d) If you flip up switch #4 and do step c) then (in our EXAMPLE) each color will be shifted to its right hand neighbor color in the palette (color code increased by one).

† Thus rust will change to the color to the left of it, black; dark brown will change to rust.....; and black (at the left of the palette) will change to white (pink). You are subtracting one unit from the color code of the color at each spot. (See Appendix). If you set the switches to the code 0101 (five) then the color code will be shifted by five. These changes are cumulative. For example, if the sum of the positive and negative color code changes is eight, you will have interchanged the low and high intensity colors. If the sume is 0 or 16, you are back to the original MC painting.

†† Always push button #7 slightly before you push buttons #1, #3 or 4.

2) How to change one color to a second color in a MC painting.

a) Get into the painting mode. (See Section III, NOTE*, p. 5.)

b) Flip up switch #6 only and all the others down. Move the joystick so the cursor is on the first color, the one you want to change (for example, put it on a light green spot somewhere in the MC painting). Tap button #1. You will see the brush indicator at the top left change to this color green. There are two rectangles in the upper right hand corner (the color mapping indicators). The left one also changes to this color.

c) Flip switch #6 down and switch #7 up. Move the joystick so the cursor is on a spot of the second color (say orange), the color you want to change to. Tap button #1. You will see the brush indicator change to orange and also the right one of the two color mappings indicators will change to orange. You are now ready to do this type of color mapping.

d) Hold down buttons #7† and #4† until the colors start changing in the painting. Soon all of the spots of the first color (light green) will have been changed to the second color (orange).

2') A second way to change one color to a second color in a MC painting uses the color codes directly (see Appendix):

a) Get into the painting mode. (See NOTE*, Section III, p. 5.)

b) Set switches #0,#1,#2 and #3 to the first color, the one you want to change. (For example, for light green set the switches to 1110, i.e., switches #3, #2 and #1 up and #0 down. See Appendix).

c) Set switches #4,#5,#6 and #7 to the second color, the color you want to change to. (For example, for orange set the switches to 0011, i.e., switches #3 and #2 down, #1 and #0 up).

† Always push button #7 slightly before you push buttons #1,#3 or #4.

d) Hold down button #7† until the colors start changing in the painting.

3) How to interchange two colors in a MC painting:

Do steps 3 a), b) and c) the same way as 2 a), b) and c).

d) Hold down buttons #7†, #4†, and #1† until the colors start to change. In the example above each spot that was light green will become orange and each spot that was orange will become light green.

NOTE: that a second use of step d) will restore the painting to its initial colors.

3') A second way to interchange two colors in a MC painting.

Do steps 3' a), b) and c) the same way as 2' a) b) and c).

d) Hold down buttons #7† and #1 until the colors start to change.

† Always push button #7 slightly before you push buttons #1, #3 or #4.

APPENDIX: COLORS AND THEIR CODES

The colors in the palette are aranged in the same order as their codes and in two groups, low intensity and high intensity, as shown in the table.

LOW INTENSITY COLORS			HIGH INTENSITY COLORS		
BINARY CODE.	(HEX) CODE	NAME	BINARY CODE†	(HEX) CODE	NAME
0000	0	black	1000	8	black
0001	1	rust	1001	9	red
0010	2	dark brown	1010	A	brown
0011	3	orange	1011	B	red-orange
0100	4	dark blue	1100	C	bright blue
0101	5	violet	1101	D	lavender
0110	6	green	1110	E	light green
0111	7	tan (off-white)	1111	F	white (pink)

† This code also indicates the switch settings for Section XIX parts 2' and 3'. Thus a "0" means a switch is down and a "1" means that it is up.